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THE MAY MEETING OF THE MARYLAND-VIRGINIA-DISTRICT OF COLUMBIA SECTION.

The seventh regular meeting of the Maryland-Virginia-District of Columbia Section of the Mathematical Association of America was held at Goucher College, Baltimore, Md., on May 15, 1920. The meeting consisted of two sessions with Professor Ralph E. Root presiding.

The attendance was forty, including the following twenty-eight members of the Association: O. S. Adams, J. J. Arnaud, H. G. Avers, Clara L. Bacon, Sarah Beall, A. A. Bennett, G. A. Bingley, J. A. Bullard, G. R. Clements, A. Cohen, J. B. Coleman, G. H. Cresse, A. Dillingham, J. B. Eppes, W. M. Hamilton, P. E. Hemke, L. S. Hulburt, W. D. Lambert, A. E. Landry, Florence P. Lewis, J. J. Luck, F. D. Murnaghan, C. E. Norwood, L. J. Reed, R. E. Root, J. E. Rowe, T. McN. Simpson, Jr., G. F. Winslow, Jr.

A generous luncheon was served to the members and their guests by Goucher College. A committee to coöperate with the National Committee on Mathematical Requirements was appointed, consisting of Professor Abraham Cohen, chairman, Professor Clara L. Bacon, and Mr. Harry English. Professor L. S. HULBURT was elected chairman of the Section, O. S. ADAMS, secretary-treasurer and Professor G. R. CLEMENTS, member of the executive committee. The next meeting will be held at Annapolis, probably early in December.

The following papers were read:

(1) "Determination of longitude by the U. S. Coast and Geodetic Survey" (Illustrated) by Miss SARAH BEALL, Coast and Geodetic Survey;

(2) "Graphical methods applied to a curve of pursuit problem" by Mr. F. V. MORLEY, Johns Hopkins University;

(3) "Modular geometry" by Professor A. A. BENNETT, Technical Staff, Army Ordnance, Baltimore, Md.;

(4) "Some intrinsic geometric properties of plane curves and the related algebraic functions" by Professor J. B. COLEMAN, University of South Carolina;

(5) "Coördinate systems in modern ballistics" by Capt. R. S. HOAR, Aberdeen Proving Grounds.

(6) "Plane curves developed upon cylinders and cones" by Professor J. J. LUCK, University of Virginia;

(7) "Some maxima and minima in elementary geometry" by Dr. T. H. GRONWALL, Technical Staff, Army Ordnance;

(8) "The mathematical basis of the Einstein theory of relativity" by Dr. F. D. MURNAGHAN, Johns Hopkins University;

(9) "Singular curves of a plane pencil" by Professor C. C. BRAMBLE, U. S. Naval Academy;

(10) "An expression for the tangential velocity of a particle" by Dr. G. H. CRESSE, U. S. Naval Academy;

(11) "A note on the roots of the derivative of a polynomial" by Professor W. H. Echols, University of Virginia.

The papers by Dr. Gronwall, Professor Bramble, Dr. Cresse and Professor Echols were read by title. Abstracts of the papers follow below. The abstracts are numbered to correspond to the titles in the list above.

1. Miss Beall's paper was a brief discussion of the method of determining the true local time at each of two stations the difference of longitude of which is to be determined, of the methods which have been used by the Survey for the comparison of those times, and finally of the work which has been accomplished in determining the longitude of stations in the United States and her possessions, and the connection with the initial longitude station Greenwich, England.

2. A particular case of the curve of pursuit gives rise to the differential equation

$$\left(\frac{dy}{dx}\right)^2 + 4c\frac{dy}{dx} + 4\frac{c^2y}{1 - x^2} = 0.$$

This is the case where the pursued point moves around a circle, the pursuer starting at the center and moving c times as fast; x is the distance from the center to the tangent to the curve of pursuit, and y the power of the pursuer with respect to the circle. The differential equation is not susceptible to ordinary methods. Mr. Morley shows that it may, however, be looked upon as defining the directions of a series of integral curves in the plane, treating x and y as Cartesian coördinates. In tracing the integral curves through the point (0, 1), and in finding the value of x when $y = 0$, it is convenient to supplement Runge's graphical methods by finding the flex and cusp loci of the integral curves. The curve of pursuit is a good test for such graphical methods, since the curve itself may be drawn accurately by a bracketing method. Comparison of the value of x obtained by graphical computation and from the curve itself showed an agreement within seven per cent., an error which can be reduced by careful work. This comparison shows graphical methods to be satisfactory and suggestive in such an equation as the above, while integration by series is likely to be troublesome at the critical points.

3. Professor Bennett's paper appears in full in the present issue of the Monthly.

4. Professor Coleman considered $y = f(x)$ as representing the equation of a curve, $f(x)$ and its derivatives being continuous. After applying the formulae for rotation of axes, the conditions upon which the resulting equation is independent of the angle of rotation give rise to invariants of different orders which were discussed.

5. The equations of motion of a projectile, referred to the horizontal and vertical at any point in its flight are:

$$\bar{x}'' = -E\bar{x}', \qquad \bar{y}'' = -E\bar{y}' - g, \qquad E = GH/C,$$

where G is a tabular function of velocity, H is a function of altitude and C is a constant throughout any given trajectory; accents represent time-derivatives. As the earth is not flat, these equations must be altered so as to relate to a single coördinate system, in place of an infinite number of instantaneous systems. Captain Hoar pointed out that the "tangent method" uses cartesian axes, horizontal and vertical at the origin, *i.e.*, the gun. The "curved method" measures x from the gun along a circle concentric with the earth, and y vertically upward from this circle. In each method, the equations are as above, plus terms in $1/r$ and higher powers, r being the radius of the earth. In practice, these terms may be omitted, the slight resulting error being absorbed in the value chosen for C.

6. The parametric equations of the space curves into which plane curves are twisted when their plane is developed on any cylinder or on any right circular cone are derived in the paper by Professor Luck. The purpose of this is to afford to students beginning the study of space curves a means of obtaining, by elementary means, the equations of certain classes of space curves rough models of which are easily available. In the case of the cylinder it is shown that if the arc length is the parameter used for the plane curve the equations of the space curve may be written down with the same parameter. The inverse problem of finding the equation of the plane curve into which a curve on the cylinder will pass when the cylinder is unrolled on the plane is also considered.

8. In this paper Dr. Murnaghan discusses the foundation of Newtonian dynamics, especially of the definitions of absolute systems of reference and vectors, Einstein's law of inertia and his hypothesis as to the nature of space which is sometimes called his "law of gravitation," and an application to the motion of a particle in the neighborhood of a single body.

10. If $f(x, y) = 0$ is the plane path of a particle, then in the equation:

$$\frac{f_x''x'^2 + 2f_{xy}''x'y' + f_y'y'^2}{\sqrt{f_x'^2 + f_y'^2}} + \frac{f_x'x'' + f_y'y''}{\sqrt{f_x'^2 + f_y'^2}} = 0$$

the second fraction is equal to $\alpha \cos \theta$, where α is the magnitude of the total acceleration and θ is the angle between the normal and the direction of acceleration. If then *e.g.*, $f(x, y)$ is taken as $b^2x^2 + a^2y^2 - a^2b^2$, and the acceleration is directed toward a focus, Dr. Cresse shows that the classical expressions for α and v in planetary motion are read off. If for a parabola of higher degree,

$$f(x, y) \equiv y - (a_0 + a_1x + a_2x^2 + a_3x^3 + \cdots + a_nx^n) \equiv y - \phi(x),$$

and the acceleration is composed of g taken vertically and of α_T, the additional acceleration along the tangent, then

$$v = \frac{\sqrt{g}}{[-\varphi'(x)]^{1/2}}\sqrt{1 + \left(\frac{dy}{dx}\right)^2}, \qquad \alpha_T = v\frac{\sqrt{g}}{2}\frac{\varphi'''(x)}{[-\varphi''(x)]^{3/2}}.$$

11. Professor Echols's "Note" was published in the last issue of this MONTHLY.

O. S. ADAMS, *Secretary-Treasurer.*